

# **STUDY GUIDE**

## **TERTIARY FILTRATION**

### **INTRODUCTION AND ADVANCED**

#### **SUBCLASS H**

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## **PREFACE**

This operator's study guide represents the results of an ambitious program. Operators of wastewater facilities, regulators, educators and local officials, jointly prepared the objectives and exam questions for this subgrade.

The objectives in this study guide have been organized into modules, and within each module they are grouped by major concepts.

### **HOW TO USE THESE OBJECTIVES WITH REFERENCES**

In preparation for the exams, you should:

1. Read all the objectives that apply to the grade level desired and write down the answers to the objectives that readily come to mind.
2. Use the references at the end of the study guide to look-up answers you don't know. This one set of references covers all of the objectives.
3. Write down the answers found in the references to those objectives you could not answer from memory.
4. Review all answered objectives until you can answer each from memory.

**IT IS ADVISABLE THAT YOU ATTEND SOME FORM OF FORMAL TRAINING IN THIS PROCESS BEFORE ATTEMPTING THE CERTIFICATION EXAM.**

### **Choosing A Test Date**

Before you choose a test date, consider the training opportunities available in your area. A listing of training opportunities and exam dates can be found in the annual DNR "Certified Operator," or by contacting your DNR District operator certification coordinator.



# INTRODUCTION

## INTRODUCTION TO TERTIARY FILTRATION

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### MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

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#### **CONCEPT: PRINCIPLE OF TERTIARY FILTRATION**

1. Discuss the primary purpose of Tertiary Filtration.
2. Describe receiving stream water quality/quantity characteristics that would require tertiary filtration.
3. Define the terms Headloss and Terminal Headloss.

#### **CONCEPT: STRUCTURE AND FUNCTION**

4. Describe where water enters and leaves a filter during the following functions:
  - A. During a Filter Run
  - B. During a Backwash Cycle
5. Describe the function of the following parts of a filter:
  - A. Media
  - B. Underdrains
  - C. Washwater troughs
  - D. Media support
6. Diagram a piping by-pass arrangement for a filter and indicate valving required to isolate the filter.
7. Identify the common media materials used for filtration.
8. Describe the location of the various media in multi-media filters.
9. Discuss the common auxiliary cleaning aids that may be used during backwashing to aid in cleaning the media.

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## MODULE B: OPERATION AND MAINTENANCE

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### CONCEPT: OPERATION

10. List the items to consider in starting-up a filter that is new, replaced, or has been stored dry.
11. Explain the operating principles of deep bed filters.
12. Describe the operating principles of shallow bed filters.
13. Discuss the expected ranges of effluent quality limits from a properly functioning plant with tertiary filtration.
14. State the normal filter run flow rates and run duration for deep bed filters.
15. State the normal filter run flow rates and run duration for shallow bed filters.
16. Discuss the situations when an operator would bypass a filter or the entire filtration process.
17. Explain the purpose of backwashing a filter.
18. Identify the range of backwash flow rates and approximate duration for deep bed filters.
19. Identify the range of backwash flow rates and approximate duration for shallow bed filters.
20. Identify the range of backwash water used as a percentage of plant flow.
21. State the maximum recommended time a deep bed filter should run before being manually backwashed.
22. State the maximum recommended time a shallow bed filter should run before being manually backwashed.
23. Outline the proper deep bed filter backwash sequence.
24. Outline the proper shallow bed filter backwash sequence.

25. List the operational situations when it is not good procedure to allow filter headloss to activate the automatic backwash.
26. List the possible reasons for a filter being able to go for more than seven days before headloss activates the automatic backwash.
27. Describe how spent backwash water is handled.
28. List the reasons for chlorinating a filter.
29. List the best procedure for removing and returning a deep bed filter to service.
30. List the best procedure for removing and returning a shallow bed filter to service.

#### **CONCEPT: MAINTENANCE**

31. List the items to consider in establishing a maintenance program for both deep bed and shallow bed tertiary filters.
32. Discuss reasons for keeping backwash water storage basins free of leaves and other debris.
33. List what to look for during filter underdrain inspections.
34. Explain the reasons for periodically cleaning and inspecting underdrain orifices of a deep bed filter, including how it is done.
35. List the consequences of having a spare parts inventory that is too small and/or too large.

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### **MODULE C: MONITORING AND TROUBLESHOOTING**

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#### **CONCEPT: MONITORING**

36. Describe the daily quantitative and visual observations of the filter operation that the operator should make.
37. Discuss what filter flows should be measured.

38. State what to observe to determine if backwashing is effective.
39. List ways an operator can monitor filtration to determine if the media is being adequately backwashed.
40. Explain how to use the results from BOD and Suspended Solids tests to determine filter effectiveness.

**CONCEPT: TROUBLESHOOTING**

41. Discuss the provisions for emergency overflows for filters.
42. Define the term "Mudball" and state where they are located in a filter.
43. Outline the corrective steps for excessive media fouling.
44. List the causes and problems of surface binding of a filter
45. List the causes and corrective actions for solids breakthrough in a Tertiary Filter.
46. List some common operational problems related to filter backwashing.
47. List the causes and corrective actions for excessive backwash rates in the following situations:
  - A. Loading Excessive Solids to the Filter
  - B. Excessive Solids Build-up in the Media
  - C. Poor Quality Effluent from the Filter
48. Describe the causes and corrective actions for the following:
  - A. Excessive Air Released During Backwashing
  - B. High Effluent Suspended Solids
  - C. Air Binding of the Filter
49. Discuss possible causes and corrective actions for excessive loss of media in a deep bed filter.

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## MODULE D: SAFETY AND CALCULATION

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### **CONCEPT: SAFETY**

50. List the items of personal safety to consider in the operation of Tertiary Filters.
51. List the precautions that should be taken when chlorinating a filter with a gas chlorination system or when using calcium hypochlorite.

### **CONCEPT: CALCULATION**

52. Given data, calculate the percent of average daily flow that is used for backwash.
53. Given data, calculate the flow rate through a filter in gallons per minute per square foot.
54. Given data, calculate the amount of backwash water used.





**ADVANCED**

## ADVANCED TERTIARY FILTRATION

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### MODULE A: PRINCIPLE, STRUCTURE AND FUNCTION

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#### CONCEPT: PRINCIPLE OF TERTIARY FILTRATION

1. List the items that should be considered in selecting a tertiary filtration system.
2. Describe the impact of upstream processes on the operation of a tertiary filter.

#### CONCEPT: STRUCTURE AND FUNCTION

3. Define the following terms as related to filter media:
  - A. Specific Gravity
  - B. Media Effective Size
  - C. Uniformity Coefficient
4. Discuss types of media, effective media size, specific gravity, and where solids should be caught in the following types of filters:
  - A. Shallow Bed Filter
  - B. Deep Bed Single Media Filter
  - C. Deep Bed Multi-Media Filter

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**MODULE B: OPERATION AND MAINTENANCE**

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**CONCEPT: OPERATION**

5. Compare deep bed filters to shallow bed filters for:
  - A. Run Time
  - B. Media Depth (Range)
  - C. Backwashing
  - D. Backwash Flow Rate (GPM/FT<sup>2</sup>)
  - E. Expected Percent Suspended Solids Removal Range with Secondary Effluents.
6. List the design and operational factors that affect the filtration rate of a tertiary filter.
7. Describe where various sized solids would be captured in a multimedia filter composed of layers of anthracite, sand, and garnet.
8. Describe the operational problems that may occur when filtration is required following pond systems.
9. Discuss the items an operator should consider when selecting replacement media for an existing filter.
10. Discuss the use of feed rates and types of filter aids (polymers) for improving filter performance.
11. Describe a problem that could be caused when excessively long filter runs occur.
12. Discuss the use of chlorine in tertiary filter operations for the following:
  - A. Control of Algae and Slime Growths
  - B. Control of Mudballs
  - C. Control of Colored Influent
  - D. Control of High Influent BOD or Coliform
  - E. Control of Odors
13. Describe the process of starting-up a new filter, or a filter that has been out-of-service.

14. State the range of rates for the following:
  - A. Air Scour Rates(Standard Cubic feet/Minute/FT<sup>2</sup>)(SCFM/FT<sup>2</sup>)
  - B. Surface Jetting Rates (GPM/FT<sup>2</sup>)
15. Describe the use and benefit from using the air scour cycle in backwashing.
16. Outline a procedure to take a filter out-of-service for an extended period of time.
17. Discuss the impact on plant operations of excessive backwash volumes due to short filter runs.
18. Describe the reason for increasing backwash rates as washwater temperatures increase.

#### **CONCEPT: MAINTENANCE**

19. List the maintenance considerations unique to the following:
  - A. Shallow Bed Filters
  - B. Deep Bed Filters
20. List the maintenance items for tertiary filtration.
21. List the rules to use in determining if spare parts should be kept on hand or purchased as needed from local suppliers.

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### **MODULE C: MONITORING AND TROUBLESHOOTING**

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#### **CONCEPT: MONITORING**

22. Discuss the two primary control measurements for filter operations.
23. Describe the methods of measuring loss of media.
24. Discuss the difficulty in getting a representative sample from filter backwash for suspended solids analysis.
25. Discuss the use of a plug sample in deep bed filters.

### **CONCEPT: TROUBLESHOOTING**

26. Describe the consequences resulting from improper installation of the porous plate assembly in a shallow bed filter.
  27. Discuss the possible causes and corrective actions for the loss of filter media.
  28. Define the term "Negative Head." Explain how it can cause air binding in a filter, and what effect this can have on filter operations.
  29. Describe the cause of large air bubbles in only certain areas of a deep bed filter during air scour.
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## **MODULE D: SAFETY AND CALCULATION**

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### **CONCEPT: SAFETY**

30. Discuss the personal safety considerations associated with chemicals used to assist filtration of smaller particles.
31. Discuss what to do in the event of a major liquid chlorine spill during the process of shock chlorinating a filter.
32. Review the hazards associated with gas chlorination, and sodium or calcium hypochlorination.

### **CONCEPT: CALCULATION**

33. Given data, calculate the cubic yards of media in a filter.
34. Given data, calculate the backwashing flow rate in GPM per square foot of surface area.
35. Given data, calculate total backwashing flow rate in GPD.
36. Given data, calculate the pounds of solids loaded to a filter, pounds of solids in the filter effluent, and the pounds of solids in the backwash.

37. Given data, calculate the average daily flow rate through a tertiary filter in GPM/FT<sup>2</sup>.
38. Given data, calculate the percent of average daily flow returned to the plant from backwashing.

## RESOURCES

1. ADVANCED WASTE TREATMENT. 1st Edition (1987), Kenneth D. Kerri. California State University, 6000 J Street, Sacramento, CA 95819-6025. Phone (916) 278-6142.
2. CONTROLLING WASTEWATER TREATMENT PROCESSES. (1984). Cortinovis, Dan. Ridgeline Press, 1136 Orchard Road, Lafayette, CA 94549.
3. OPERATION OF MUNICIPAL WASTEWATER TREATMENT PLANTS. Manual of Practice No.11(MOP 11), 2nd Addition (1990), Volumes I, II, and III. Water Environment Federation (Old WPCF), 601 Wythe Street, Alexandria, VA 22314-1994. Phone (800) 666-0206. (MOP 11, 1976 can still be used as a reference)
4. Young, James C. FILTRATION OF WASTEWATER USING SINGLE-MEDIA UNSTRATIFIED BEDS.(1975); OPERATING PROBLEMS WITH GRANULAR-METER FILTERS USED FOR WASTEWATER TREATMENT (1978); COMPARISON OF SHALLOW-BED AND DEEP-BED FILTERS FOR WASTEWATER TREATMENT (1979). Iowa State University, Ames, IA 50011.